FOREST PEST MANAGEMENT

BIOLOGICAL EVALUATION

R2-86-2

Mountain Pine Beetle Mortality in Ponderosa Pine Black Hills of South Dakota and Wyo

1986

United States Department of Agriculture

Forest Service

Forest Pest Management
Denver, Colorado

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INTRODUCTION

Historically, mountain pine beetle, Dendroctonus ponderosae Hopk., has caused extensive mortality to ponderosa pine, Pinus ponderosa Laws, in the Black Hills of South Dakota and Wyoming. On average, infestations occurred on an 11-year cycle (9.3 infestations per 100 years). About every third infestation (2.7 infestations per 100 years) caused a high level of tree mortality similar to the infestations of 1895-1908 and 1969-1981 (Lessard 1984).

The pattern of infestation, generally, is the same for each major episode. Scattered trees are first detected in the high elevation areas around Warren Peak in Wyoming, the Exemption Area in the northern Hills and Harney Peak in the southern Hills. At these endemic levels, a number of factors predispose individual trees to attack by mountain pine beetle. Of primary importance in the Black Hills is Armillaria root rot (Hinds, et al., 1984; Lessard, et al., 1985). With an increase in the intensity of infestation, groups of tree mortality become more apparent throughout the Limestone Plateau and scattered trees are detected in the Crystalline Basin. During most infestations (9.3/100 years), the process reverses back to scattered trees at high elevations during the declining phase. Under the extremes (2.7/100 years) groups of infested trees coalesce into larger groups and infestation intensifies in the low elevation Crystalline Basin. Again, during the decline phase, the process reverses to scattered trees at high elevations.

Over an extensive area such as the Black Hills, an infestation is, in reality, a composite of infestations occurring at the stand level. The duration and intensity of infestation in the stand is directly related to stand structure (Lessard 1982) and is a function of the number of trees in the stand between 7.1 - 13.0 inches d.b.h. and stand size. Generally, even-aged stands are more susceptible to mountain pine beetle than uneven-aged stands.

The objectives of this evaluation are:

1. To summarize the latest infestation in the Black Hills (1968 to present).

2. To review the broad historical associations between climate, fire, silviculture and mountain pine beetle.

3. To predict future trends of the mountain pine beetle based on long term associations presented.

METHODS

To summarize the latest infestation trend in the Black Hills, records from annual aerial reconnaissance flights were reviewed. During these flights mountain pine beetle-caused tree mortality is mapped for both location and intensity. Since about 9 months are required for a tree to fade and be visible from the air, the mortality mapped in any one year represents the infestation for the previous year. If the flight is timed properly, 2 past years of infestation can be distinguished based on the color of the foliage. However, tree fading is highly variable between years and separation of trees by year of infestation is often subjective. Also, trees fade at differential rates. Therefore, estimates of mortality are often lower than actual mortality.

To obtain a reliable picture of relative infestation trend, a 3-year running average of infested trees is used in this evaluation. The dates of mortality are adjusted to reflect the actual year trees were attacked.

To estimate the 1986 infestation sample plots were established at 20 locations in the Black Hills of South Dakota (Figure 1). At each location, two 40-chain long by one chain wide strip cruises were established. On each line all 1984, 1985, and 1986 attacked trees were tallied by diameter (d.b.h.).

RESULTS AND DISCUSSION

Mountain pine beetle populations were epidemic from 1969 to 1981 with the peak of tree mortality in 1974 (9.7 trees per acre; Frye 1974) in the Black Hills (Table 1; Figure 2). Since 1982, beetle-caused tree mortality has remained at relatively low levels (Table 2; Figure 3). Tree mortality increased nearly two-fold from 1982 to 1983. Mountain pine beetle populations were substantially reduced during the winter of 1983-84. This winter mortality resulted in a substantial decline in tree mortality (0.3 ± 0.3 trees per acre) in 1984 to near endemic levels (Lessard 1984). Beetle-caused tree mortality increased (1.6x) from 1984 to 1985 and decreased (0.6x) from 1985 to 1986. On average, beetle-caused tree mortality was static from 1982 to 1986 with an annual average drain of 1.3 trees per acre.

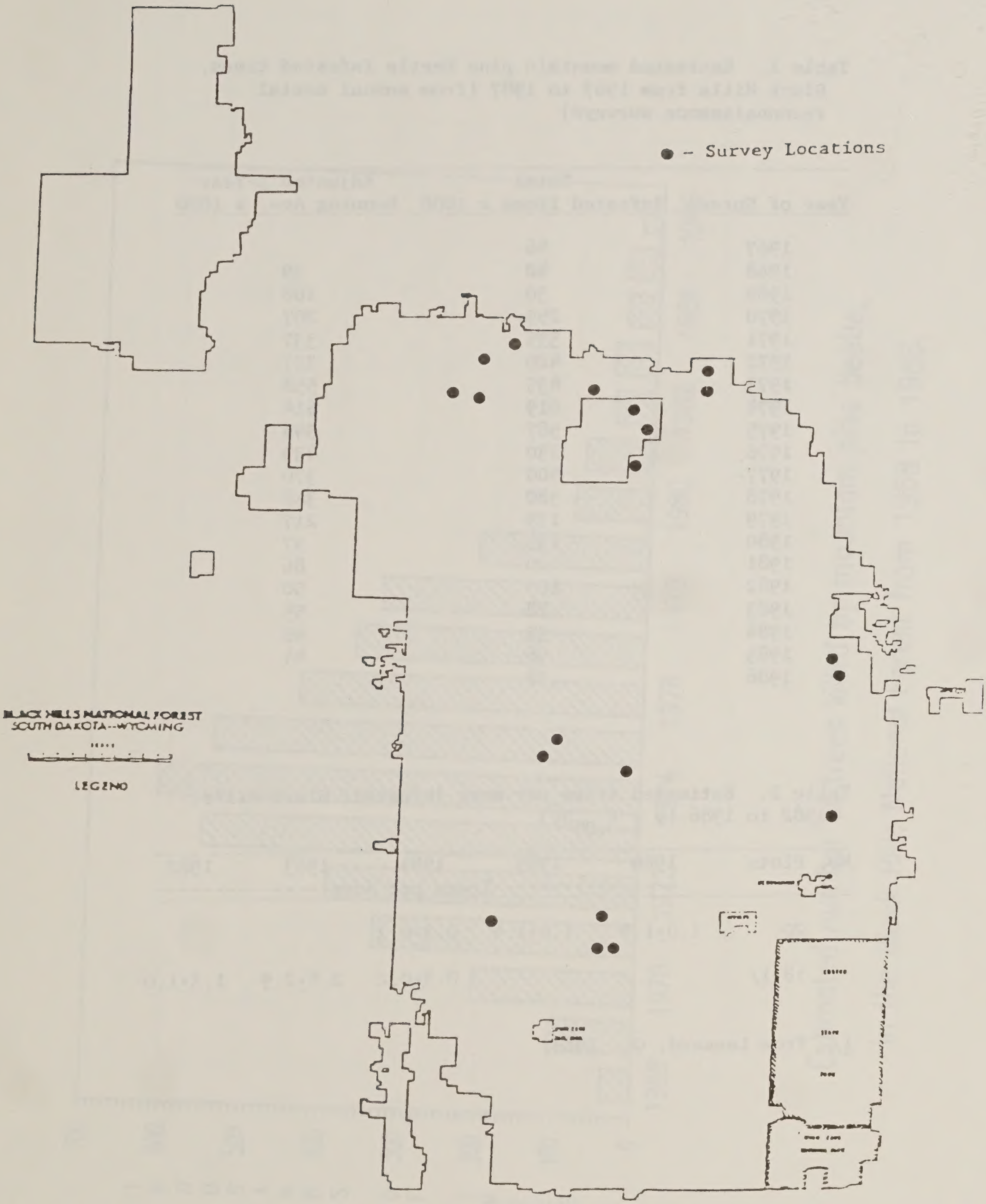


Figure 1. Location of mountain pine beetle survey plots, Black Hills of South Dakota, 1986.

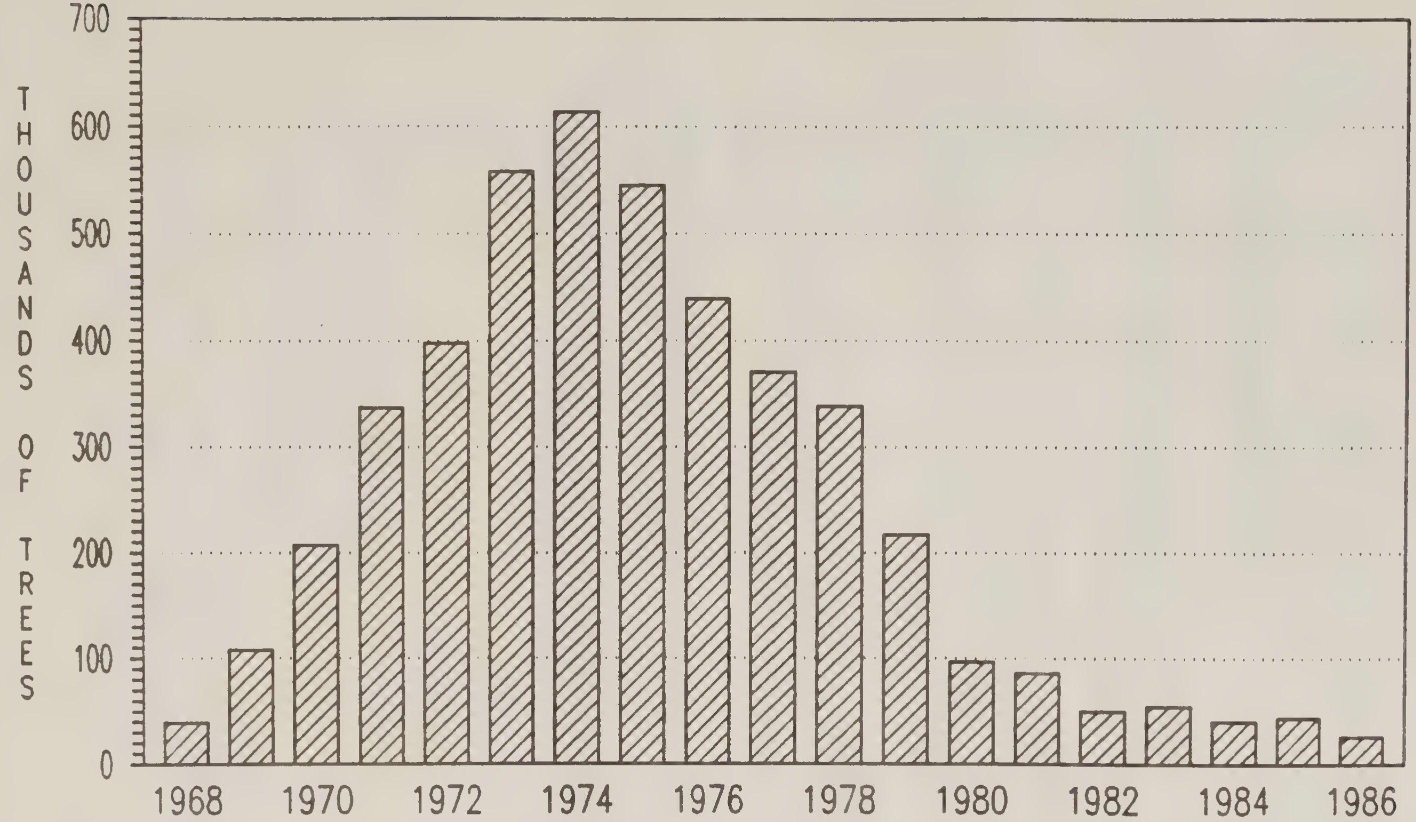
Table 1. Estimated mountain pine beetle infested trees, Black Hills from 1967 to 1987 (from annual aerial reconnaissance surveys)

Year of Survey	Total Infested Trees x 1000	Adjusted 3-Year Running Ave. x 1000
1967	46	
1968	40	39
1969	30	108
1970	255	207
1971	335	337
1972	420	397
1973	435	558
1974	819	614
1975	587	545
1976	230	439
1977	500	370
1978	380	338
1979	135	217
1980	135	97
1981	20	86
1982	103	50
1983	28	55
1984	35	40
1985	58	44
1986	38	

Table 2. Estimated trees per acre infested, Black Hills, 1982 to 1986 ($y \pm t_{.05}Sy$)

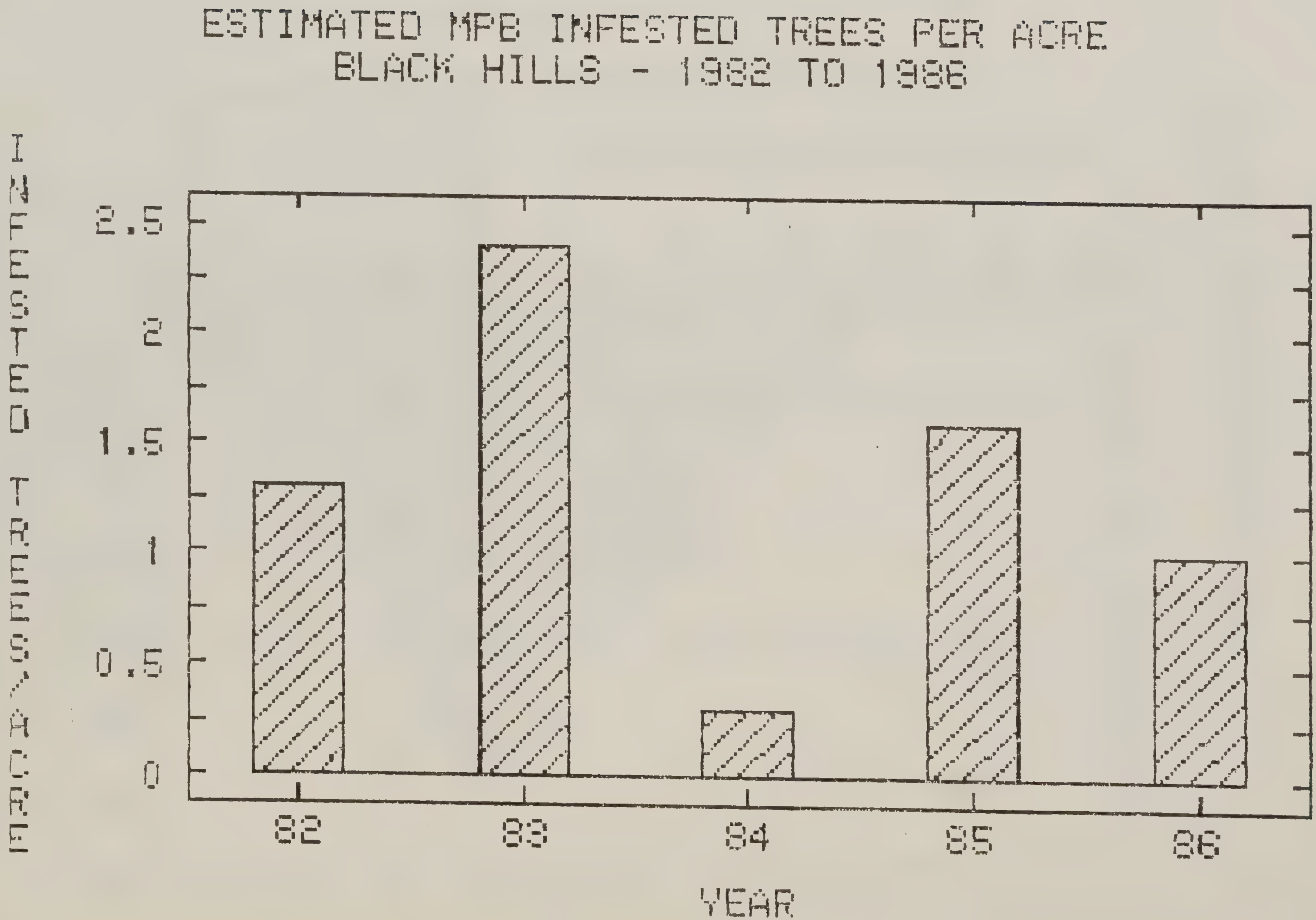
No. Plots	1986	1985	1984	1983	1982
	Trees per Acre				
20	1.0±1.9	1.6±1.4	0.3±0.3		
18 1/			0.3±0.2	2.4±2.9	1.3±1.0

1/ From Lessard, G. 1984.



Estimated number of trees killed by mountain pine beetle, in the Black Hills National Forest from 1968 to 1986.

Figure 3


ESTIMATED MPB INFESTED TREES PER ACRE
BLACK HILLS - 1982 TO 1986
INFESTED TREES/ACRE
2.5
2
1.5
1
0.5
0
82
83
84
85
86
YEAR

Within the exemption area (Table 3) mountain pine beetle populations declined (0.6x) from 1985 to 1986. The average diameter of 1986 infested trees was 7.5 inches (d.b.h.). At this small diameter, beetle brood production, survival and subsequent 1987 tree mortality are expected to be low.

On Tollgate Flats, beetle populations declined to endemic levels from 1985 to 1986. To the north, around Citadel Rock, populations declined slightly (0.8x) from 1985 to 1986. In this area 2.56 trees per acre were infested with an average diameter of 12.2 inches (d.b.h.). Populations are expected to increase in 1987.

Around Crook Mountain populations declined (0.7x) from 1985 to 1986 to 0.57 trees per acre. Beetle populations are expected to remain at low levels in 1987.

Endemic populations were found east of Pactola Reservoir and northwest of Deerfield Lake near Rhoads Spring. These populations are expected to remain at low levels in 1987. Significant Ips beetle infestations were found near Pactola Reservoir (6.88 trees/acre) and Rhoads Spring (1.00 trees per acre).

An increasing population (1.9x) was found west of Hill City in Long Draw and Reno Gulch. Mortality in 1986 was 1.38 trees per acre. These populations are expected to increase in 1987.

Populations in Thompson Draw decreased to endemic in 1986 and should remain endemic in 1987.

The remaining four plots (14, 15, 16 and 20) did not sustain mountain pine beetle-caused tree mortality from 1984 to 1986.

Table 3. Trees per acre infested in 1985 and 1986 and expected 1987 trend, Black Hills, South Dakota

Area	Plot #	Trees Per Acre Infested 1985	1986	Expected Trend 1987
Exemption Area	5	13.75	8.25	Decline
	6	.63	.75	
	7	3.00	1.38	
	10	.38	0	
Mean		4.44	2.60	
Tollgate Flats	1	1.88	0	Static
	2	2.13	.13	
Mean		2.01	.06	
Citadel Rock	3	2.55	2.73	Increase
	4	3.63	2.38	
Mean		3.09	2.56	
Crook Mountain	8	1.63	1.13	Static
	9	0	0	
Mean		.82	.57	
Pactola Reservoir	11	0	.13	Static
	12	0	.13	
Mean		0	.13	
Rhoads Spring	13	.25	.13	Static
Hill City	17	.25	.88	Increase
	18	.75	1.88	
Mean		.50	1.38	
Thompson Draw	19	.50	.13	Static

DROUGHT HISTORY--A 10-year running average of annual precipitation (Rapid City, SD) is displayed in Figure 4. The average period ($y \pm t_{.05}\ Sy$) between droughts is 20.3 ± 1.5 years. The average period between precipitation maximums is 20.3 ± 2.9 years. There were four major episodes of drought in the past 100 years; 1890-1900, 1930-1940, 1947-1961 and 1973-1985 (Table 4). The 1930's saw the severist drought of the century. Each successive drought declined by about 45 percent. The average drought lasts 12.5 ± 3.0 years.

ANN. PRECIP. BLACK HILLS N.F. 1897–1985

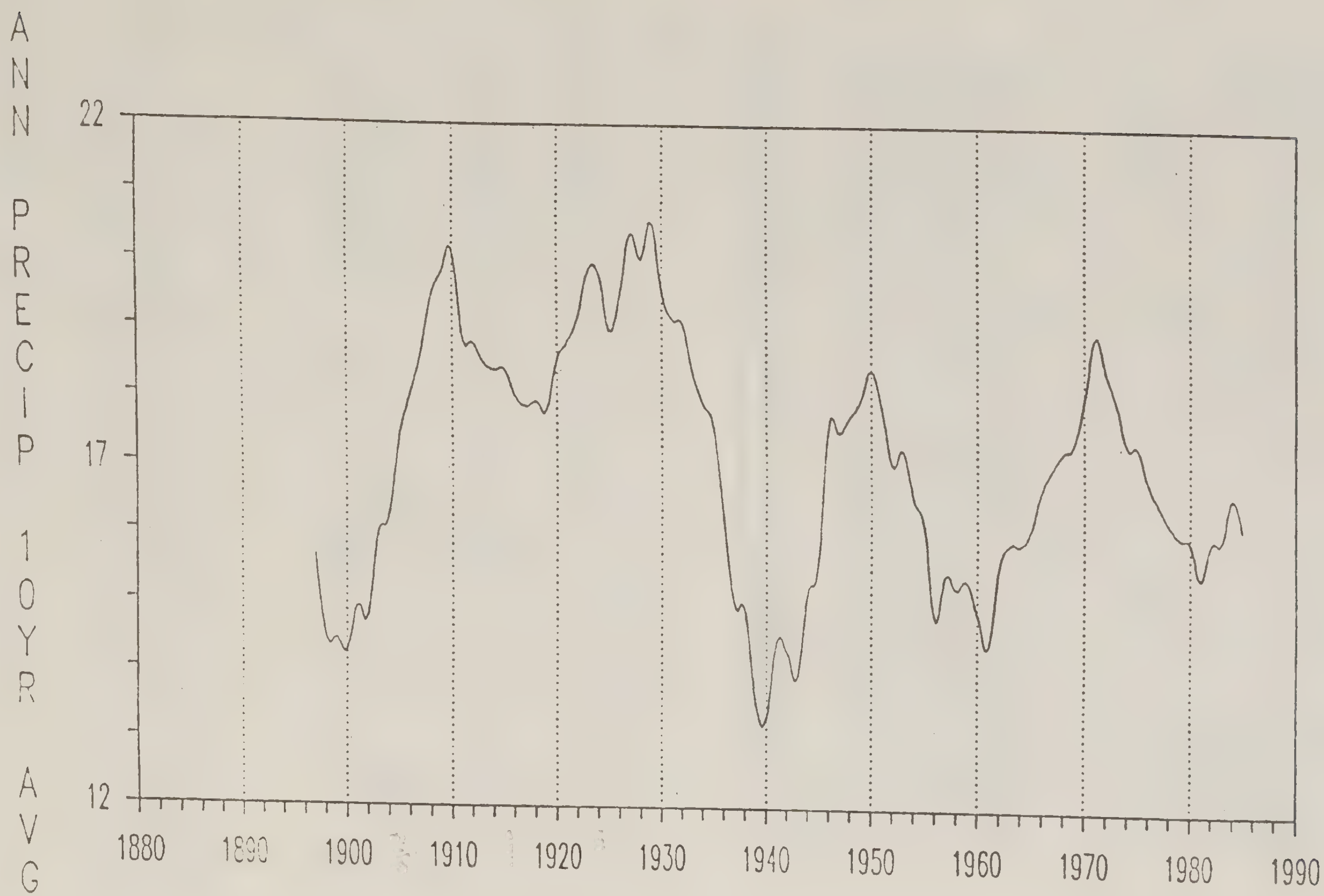


Table 4. Summary of drought periods, Black Hills

Period Date	Average % Deviation from Normal Precipitation ($\bar{y} \pm S\bar{y}$)		Period Years
1890-1900	-16.2 ± 5.2		11
1901-1929		+15.3 ± 4.5	29
1930-1940	-25.5 ± 7.0		11
1941-1946		+21.3 ± 10.5	6
1947-1961	-14.0 ± 3.8		15
1961-1972		+10.6 ± 4.3	11
1973-1985	- 7.8 ± 5.1		13

MOUNTAIN PINE BEETLE HISTORY--Four recorded mountain pine beetle outbreaks occurred in the past 100 years. The first of these occurred between 1895 and 1908 with a peak in 1901. This was the largest outbreak ever recorded with an estimated 1-2 billion board feet of ponderosa pine mortality attributed to mountain pine beetle (Blackman 1931). For about the next 25 years mountain pine beetle-caused tree mortality was considered insignificant. In 1931 a series of 4 outbreaks began (Thompson 1975). Each succeeding outbreak peaked at higher levels of beetle-caused tree mortality (Table 5).

Table 5. Summary of major outbreaks of mountain pine beetle, Black Hills

Period	Peak Date	Estimated Volume Lost (MMBF)
1895-1908	1901	1,000 - 2,000
1931-1942	1939	2.5 - 7.5
1945-1955	1949	15 - 20
1957-1965	1963	25 - 50
1969-1981	1974	200 - 300

FIRE HISTORY--The recorded fire history of the Black Hills dates back to 1880 (Appendix A). Organized fire protection began in 1909. By 1942, there was a fairly aggressive fire organization in the Black Hills.

M. W. Thompson 1/ describes the organization:

> "The regular personnel who administer the Black Hills and Harney National Forests total twenty-five. This number includes twelve Rangers, seven field men on the Supervisors' staffs at Custer and Deadwood, and six office men. All regular administrative men have the prevention and control of fire as their highest priority job even though their regular duties consist entirely of other work. In recent years a fire assistant who devotes most of his time to fire work has been attached to each Supervisor's office. In addition to the regular personnel, the CCC organization has been the backbone of the fire organization in recent years, particularly when large or aggressive fires are involved. CCC crews can be trained and organized in advance and led by experienced foremen who have been working with them. This has given a tremendous advantage in handling large fires when they occur. However, available CCC forces have rapidly been reduced from a high of eight CCC camps on each Forest to a present total of four for both Forests. CCC camps represent a force of 100 to 200 men with an average of five experienced foremen and a CCC superintendent."

The post-war era saw an increase in technology with aerial attack using fixed-wing bombers and later with helicopters.

The fire frequency for all fires in the Black Hills is about 140 fires per year 2/. Brown 3/ found an average of 84.7 fires per year occurred between 1909 and 1930. From 1931 to 1940 the fire frequency increased to 143.2 fires per year. The fire frequency in the southern Hills (Harney NF) was greater than the northern Hills - 80.7 fires per year and 62.5 fires per year, respectively. However, the average size of fires in the northern Hills was ten-fold greater than the southern Hills - 97.2 acres and 9.6 acres, respectively.

A 10-year running average of large fire frequency in the Black Hills is displayed in Figure 5. The average period ($\bar{y} \pm t_{.05} S_{\bar{y}}$) of large fires is 21.5 ± 6.4 years. The period between minimums in large fire occurrence is 22.3 ± 7.4

1/ M. W. Thompson. 1942. Cumulative silvical report - Harney National Forest. On file at TFP&CFM, Lakewood, CO.

2/ Al Braddock - personal communication

3/ A. A. Brown. 1942. Cumulative silvical report - Harney National Forest. On file at TFP&CFM, Lakewood, CO.

years. The two worst years for numbers of large fires were 1911 and 1985. In 1911, ten large fires consumed 5,740 acres. In 1985, fifteen large fires (eight greater than 100 acres) consumed 42,095 acres.

Prior to 1909 the average size of large fires was 9,857 acres. From 1909 through 1946, the average size decreased to 2,328 acres. From 1947 to 1986 the average size increased, though not significantly, to 2,889 acres. In addition, from 1909 through 1946 large fires occurred on an average of 0.97 per year. The average number of large fires change little from 1947 to 1986, to 1.03 per year.

Large fires by cause from 1909 to 1986 are displayed in Table 6. Over the period about 50 percent of the large fires are person/human-caused; 25 percent lightning-caused and 25 percent of unknown origin. From the pre-war period to the post-war period, there was no significant change in the percent of person/human-caused fires. There was, however, a substantial decline in fires of unknown origin and a corresponding increase in lightning-caused fires.

Table 6. Number and percent of large fires by cause - pre- and post-WWII.

	Lightning		Person/Human		Unknown		
Period	#	%	#	%	#	%	Total
1909-1946	5	13.2	17	44.7	16	42.1	38
1947-1986	14	35.0	21	52.5	5	12.5	40
Total	19	24.4	38	48.7	21	26.9	78

The average fire size by cause is tabulated below:

Lightning	Person/Human	Unknown
Acres ($y \pm S_y$)		
4796 ± 1593	1941 ± 619	1891 ± 773

Using a t-test, there was a significant difference ($t_\alpha = .05$) in size between lightning- and person/human-caused fires. There was a slight difference ($t_\alpha = .2$) between lightning- and unknown-caused fires and no significant difference between person/human- and unknown-caused fire size.

The average fire size by cause for pre- and post-war periods are tabulated below:

Period	Lightning	Person/Human	Unknown
	------------Acres ($\bar{y} \pm S\bar{y}$)		----------------
1909-1946	6141 ± 4146	2544 ± 1278	878 ± 203
1947-1986	4315 ± 1678	1452 ± 446	4928 ± 2800

Using a t-test, there was no significant difference in fire size between lightning-caused fires from 1909 to 1946 and lightning-caused fires from 1947 to 1986. Also, there was no significant difference in fire size between person/human-caused fires from 1909 to 1946 and person/human-caused fires from 1947 to 1986. However, there was a significant difference (t =.02) between fires of unknown origin between the two periods.

In summary:

1. Fire suppression made a substantial impact on the size of large fires.

2. Fire frequency of all fires has been relatively constant since 1931.

3. Fire frequency of large fires has not changed with pre- and post-war technologies.

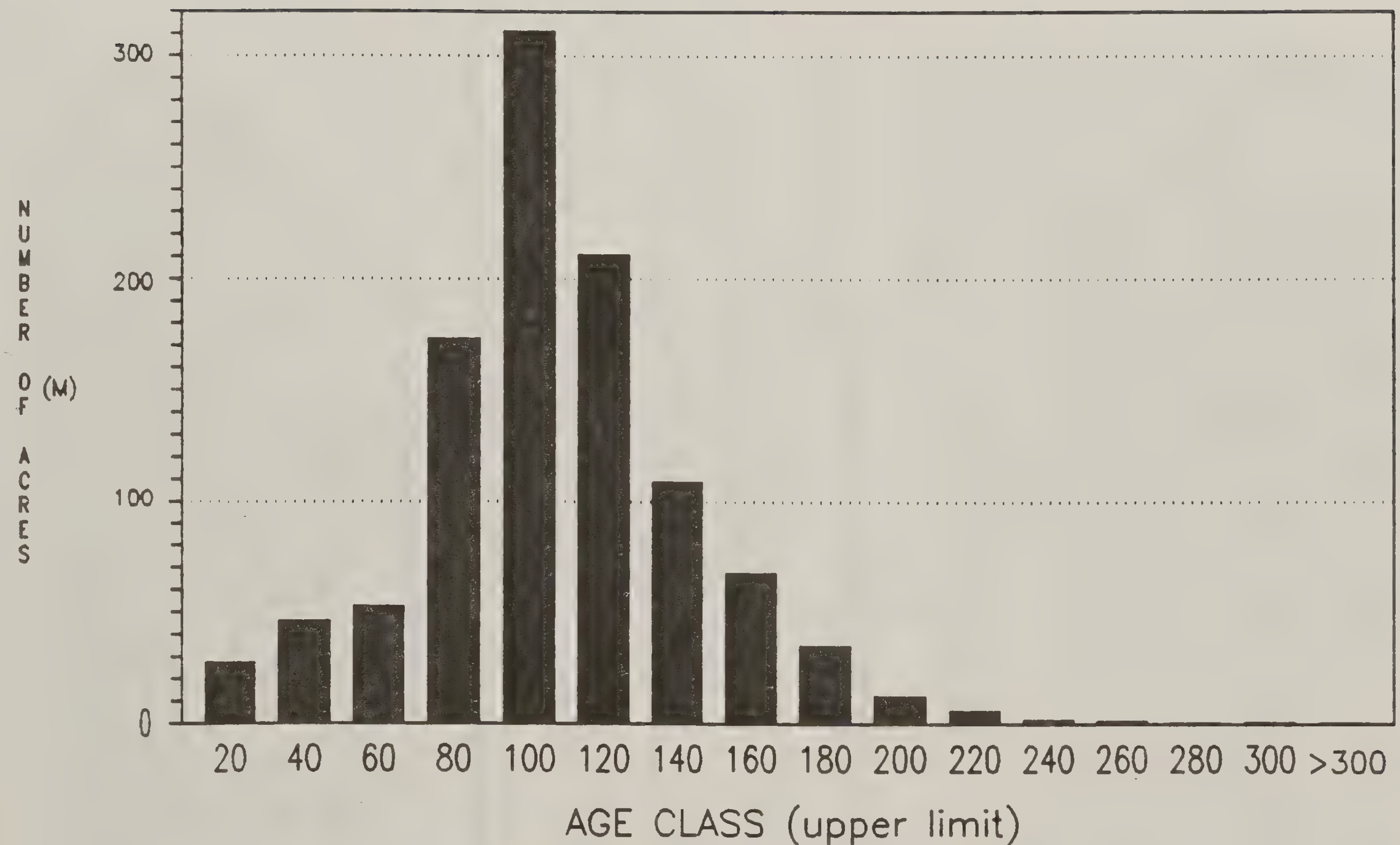
4. The average size of large fires has not changed with pre- and post-war technologies.

5. Smaller fires are being categorized as larger fires (see 1985 Appendix A).

6. Lightning-caused fires are significantly larger than person/human-caused fires.

7. We are better able to diagnose the cause of fires.

REGENERATION HISTORY--Age class distributions for the ponderosa pine cover type are displayed in Figure 5. Over the past 110 years 6.3 percent of the acres were regenerated per decade (66,551 acres per decade). The majority of this regeneration (11.5 percent per decade) occurred between 1877 and 1926 (121,275 acres per decade). During this period, the forest was being regulated at an average rotation age of about 87 years. In the past 60 years, only 2.0 percent of the acres have been regenerated per decade (20,948 acres per decade). Two percent regeneration per decade represents an average rotation age of about 500 years. Regulation of the



Acres of ponderosa pine cover type by age class in the Black Hills National Forest, Wyoming and South Dakota.

entire ponderosa pine cover type at a rotation age of 110 years would require about 95,600 acres (9.1 percent) of regeneration per decade.

ASSOCIATIONS AMONG DROUGHT, FIRE AND MOUNTAIN PINE BEETLE--Over the past 100 years certain recurring patterns imply associations between drought, fire and mountain pine beetle (Figure 6). Fire frequency of large fires will be considered first. Multiple large fires (3 or more per year) almost always occur in years of below normal precipitation. The exceptions are 1942 and 1966. Both 1942 and 1966 mark the end of two major infestations of mountain pine beetle and associated cumulative fuel loading. The two worst fire years in history occurred in 1911 (10 large fires) and 1985 (8 large fires). Both occurred 3 and 4 years, respectively, after the two largest recorded mountain pine beetle infestations of 1895 to 1908 and 1969 to 1981.

Looking at total acres burned, there were seven years in which about 20,000 acres or more burned. Generally, these fires occur in pairs and are associated with periods of drought. The first of these pairs occurred in 1893 (23,000 acres) and 1899 (38,000 acres) during the drought of 1890 to 1900. The second pair occurred in 1931 (23,759 acres) and 1939 (21,857 acres) during the drought of 1930 to 1940. The third pair occurred in 1960 (19,082 acres) and 1964 (22,595 acres). The associated drought occurred between 1947 and 1961. The 1964 fires were outside this drought period but did occur in a year of below normal precipitation and near the end of the third in a series of mountain pine beetle infestations begun in 1931 and ended in 1966. The last of these fires occurred in 1985 (41,776 acres) during the drought period of 1973 to 1985. As previously mentioned, this fire year contained 8 fires in excess of 100 acres and occurred four years after the second largest record mountain pine beetle infestation.

FUTURE TRENDS--If the drought cycle continues, a major drought period should occur between 1993 and 2005 with a minimum around 1999. Tree-ring chronologies (Fritts and Lough 1985) show that major temperature highs occur in the western United States on a 63.3 ± 7.6 year cycle ($y \pm Sy$). The last temperature peak was about 1935. Therefore, the next peak should occur about 1998 or 1999.) This drought combined with the backlog of old aged ponderosa pine will undoubtedly produce a substantial mountain pine beetle outbreak. With the current level of management on the Black Hills, primarily thinning, the level of loss would not likely reach the historical high. However, a volume loss of 250-500 MMBF would be within historical perspective.

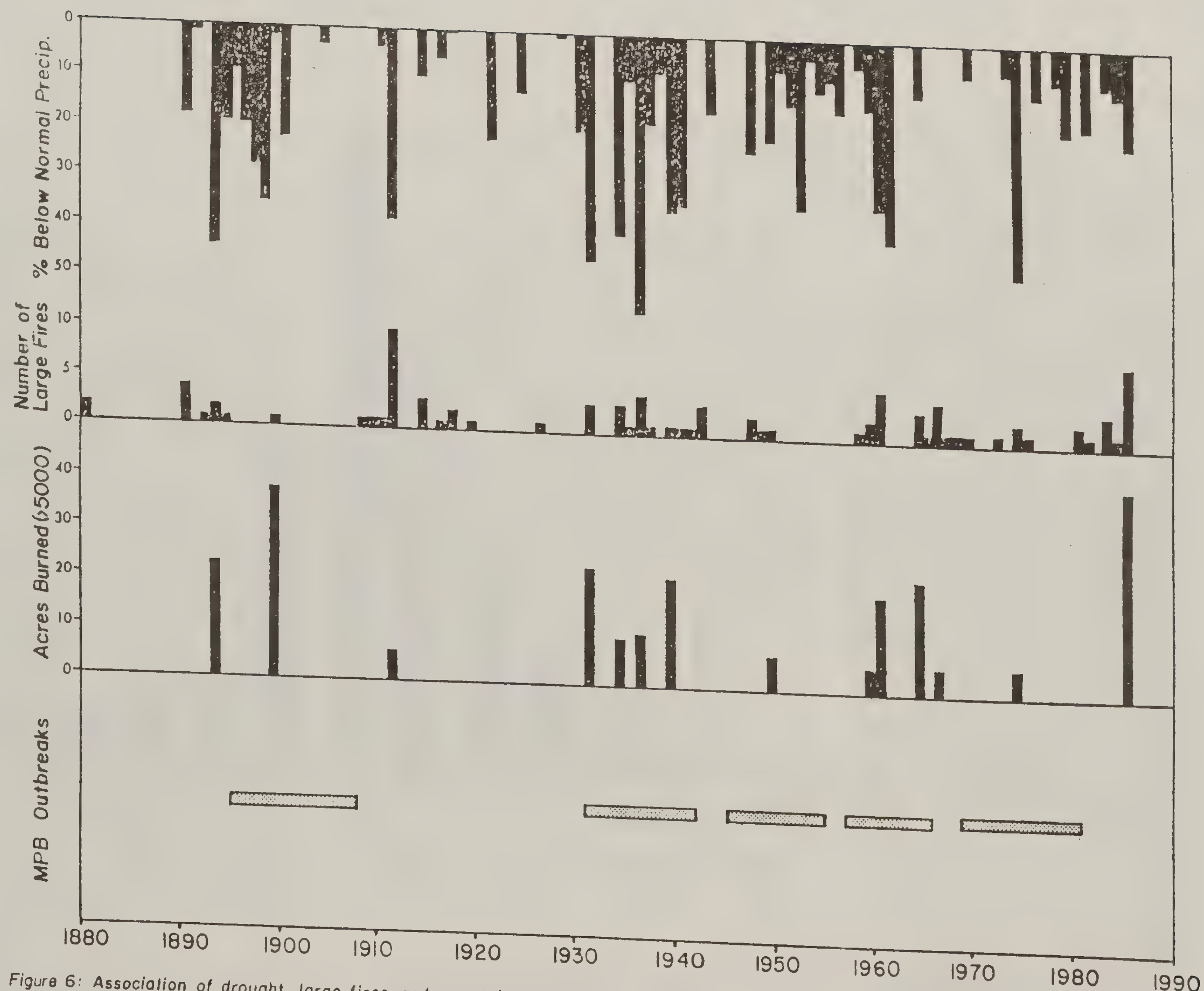


Figure 6: Association of drought, large fires, and mountain pine beetle outbreaks in the Black Hills of South Dakota and Wyoming.

b. Where spruce or aspen is not sufficient to regenerate the stand, reduce the rotation age of the ponderosa pine component from 110 years to 90 years.

In unmanaged stands where Armillaria root disease is not pathogenic consider dropping the first step of the shelterwood and going straight to a seed cut. A reduction in current yield would be traded for an increase in acres of regeneration. The future stand could be managed at a 110 year rotation age.

MANAGEMENT ALTERNATIVES

1. Continue present level of management. This alternative involves harvesting timber at the levels indicated in the Forest Plan. Roundwood and sawtimber production for the 1981-1990 decade are set at 68.4 MMCF annually. For the next four decades this production, on average, drops 55 percent to 37.9 MMCF annually. If this production drop translates directly to a reduction in acres regenerated, then about one percent of the cover type will be regulated per decade. Thinning for the 1981-1990 decade is set at 37,400 acres annually. For the next four decades thinning, on average, drops to an annual level of 11,600 acres - a 69 percent drop.

Currently, 72 percent of the acres of ponderosa pine cover type is in excess of 80 years of age. Continuing present levels of management will increase the number of acres in excess of 80 years of age to 90 percent by 2031 and 96 percent by 2071. This translates to an increase in susceptibility to the mountain pine beetle of 18% by 2031 and 24 percent by 2071. With this alternative the Forest needs to determine in what locations mountain pine beetle will be allowed to express its dominance and what areas the Forest will prevent mountain pine beetle from being a dominant future factor.

Thinning will mitigate some of the increase in susceptibility to mountain pine beetle but at a decreasing rate from 1991 through 2031. In addition, commercial thinnings in stands infested with Armillaria root disease may not decrease the susceptibility of the stands to mountain pine beetle.

2. Increase acres of thinning. This alternative involves an increase in precommercial thinning above the level of the Forest Plan and selectively thinning stands where Armillaria root disease is absent or not likely to increase in extent or intensity.

3. Increase acres of regeneration. This alternative involves increasing both acres of ponderosa pine regeneration and conversion of ponderosa pine cover type to spruce and aspen.

Where Armillaria root disease is pathogenic there are two options available:

a. Where a commercial stand of ponderosa pine exists and sufficient spruce or aspen is available to regenerate the stand, remove all commercial ponderosa pine.

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APPENDIX A

HISTORICAL FIRES ON THE BLACK HILLS

YEAR	NAME	ACREAGE	CAUSE	LOCATION
PRIOR				
1880	DEADWOOD	UNKNOWN	UNKNOWN	
1880	SHEPHERD GULCH	UNKNOWN	UNKNOWN	
1880	RATTLE SNAKE	UNKNOWN	UNKNOWN	
1880	POLE CREEK	3,000	UNKNOWN	
1890	DUMONT	3,000	UNKNOWN	
1890	SAVOY	1,000	UNKNOWN	
	BLACK TAIL	UNKNOWN	UNKNOWN	
	BEAVER CREEK	UNKNOWN	UNKNOWN	
1892 ?	VICTORIA	UNKNOWN	UNKNOWN	
1893	TWO BIT	3,000	UNKNOWN	
1893	ROUBAIX	20,000	UNKNOWN	
1894?	CARTER	UNKNOWN	UNKNOWN	
1899	IRON CREEK	38,000	PERSON/HUMAN CAUSED	
1908	GALENA	2,000	UNKNOWN	
1909	PACTOLA	UNKNOWN	UNKNOWN	
1910	REDFERN	1,784	UNKNOWN	1S,3E,SEC.10
1911	SKUNKS	300	CAMPER	1N,6E,SEC.11
1911	EAST BOUNDARY	400	UNKNOWN	1N,6E,SEC.24
1911	R.C. B.H. & W.	1,200	RAILROAD	1N,6E,SEC.22
1911	EAST BOUNDARY #2	400	UNKNOWN	1N,7E,SEC.19
1911	THEIN	300	LIGHTNING	3N,1E,SEC.10
1911	SMITH PEAK	1,280	UNKNOWN	3N,2E,SEC.35
1911	LOOKOUT HILL	300	UNKNOWN	1N,1E,SEC. 1
1911	SHEEP MOUNTAIN	320	MISC.	5N,3E,SEC.22
1911	THEIN #2	640	UNKNOWN	3N,1E,SEC.14
1911	TILLY	600	HUNTER	5N,3E,SEC.22
1914	STONEBERGER	500	UNKNOWN	1N,7E,SEC.19
1914	BLACK HAWK	800	UNKNOWN	2N,6E,SEC.13
1914	STEARNS PARK	500	UNKNOWN	4N,1E,SEC.18
1916	SHOO FLY	520	RAILROAD	1N,6E,SEC.14
1917	STONEBERGER	2,500	DEBRIS BURN	1N,7E,SEC.19
1917	WHITEWOOD CANYON	600	RAILROAD	3N,1E,SEC. 5
1919	STATE PARK	3,300		
1926	SPRING CREEK	788	CAMPER	1S,6E,SEC. 4
1931	LOST GULCH	1,079	SMOKER	5N,4E,SEC.20
1931	ROCHFORD	21,640	INCENDIARY	2N,3E,SEC.18
1931	BLANCHARD	1,040	UNKNOWN	1S,4E,SEC.16
1934	BLOODY GULCH	576	LUMBERING	2N,3E,SED.36
1934	BLACK FOX	635	LIGHTNING	2N,2E,SEC. 3
1934	SUNDANCE BURN	8,361	SMOKER	51N,63W,SEC.12
1935	ROSS ALLAN	437	DEBRIS BURN	47N,60W,SEC. 9
1936	FOURTH OF JULY	1,227	SMOKER	47N,60W,SEC.17
1936	MOSKEE	7,338	LIGHTNING	49N,61W,SEC.13
1936	JOHNSTON	760	CAMPFIRE	1N,6E,SEC. 6
1936	BATTLE CREEK	1,160	CAMPFIRE	2S,6E,SEC.__
1937	GALENA MILL	1,181	LUMBERING	5N,4E,SEC.35
1939	MC VEY	21,857	LIGHTNING	1S,3E,SEC.10

HISTORICAL FIRES ON THE BLACK HILLS

YEAR	NAME	ACREAGE	CAUSE	LOCATION
1940	MATT	577	LIGHTNING	1S,3E,SEC.10
1941	SPOKANE	385	UNKNOWN	2S,7E,SEC.31
1943		914	UNKNOWN	5S,2E,______
1943		616	UNKNOWN	8S,2E,______
1943		312	UNKNOWN	7S,4E,______
1947		368		8S,3E,______
1947	BUSKALS	2,200	SMOKER	3N,2E,SEC.26
1948	LIME KILN	512	DEBRIS BURN	5S,4E,SEC.23
1949	BIG ELK	6,630	SMOKER	3N,5E,SEC.3
1958	BULL FLATS	422	TRACTOR EXHAUST	4S,3E,SEC. 4
1959	DEADWOOD	4,501	DEBRIS BURN	5N,3E,SEC.29
1959	NEMO	273	POWER LINE	
1960	MCLAIN FIRE	2,000		
1960	WHITEHORSE	375	POWER LINE	
1960	GREEN CANYON	5,900	LIGHTNING	
1960	WILDCAT	10,336	LIGHTNING	
1960	BEAVER CREEK	471	PERSON/HUMAN-CAUSED	
1961	NONE			
1962	NONE			
1963	NONE			
1964	WILLOW CREEK	595	DEBRIS BURN	3S,4E,SEC.25
1964	WIND CAVE	15,000	UNKNOWN	-NAT'L PARK SERVICE
1964	ABERG	7,000 EST.	- STATE FIRE	
1965	NONE			
1966	VENTLING DRAW	1,556	LIGHTNING	4S,4E,SEC.32
1966	RED CANYON	662	RAILROAD	8S,3E,SEC.21
1966	LONE BUTTE	380	LIGHTNING	GRASSLANDS
1966	DEWEY	2,562	RAILROAD	6S,1E,SEC.18
1967	NONE			
1968	FREELAND BASIN	610	INCENDIARY	5S,3E,SEC.17,18 19,20
1969	CLIFTON	385	RAILROAD	42N,60W,SEC.21
1970	NONE			
1971	NONE			
1972	GULL	569	RAILROAD	8S,2E,SEC.28
1973	NONE			
1974	PILGER MOUNTAIN	1,782	LIGHTNING	6S,2E,SEC.17
1974	ARGYLE	3,723	LIGHTNING	6S,4E,SEC.34
1975	GULL HIILL	737	LIGHTNING	
1980	LORING SIDING(6/27/80)	553	LIGHTNING	5S,4E,SEC.31
1980	MUD SPRINGS (7/19/80)	950	LIGHTNING	3S,2E,SEC.11
1981	EVANS (4/9/81)	257	BURNING BLDG.	5S,4E,SEC.24
1983	RIFLE PIT (7/5/83)	272	(OFF FOREST IN WYOMING - ABOVE SPEARFISH)	
1983	ELK MOUNTAIN (8/29/83)	1,392	WELDING	43N,60W,SEC.16
1983	PINE(9/7/83)	132	POWER SAW	4N,5E,SEC.18
1984	GREEN CANYON#3(8/4/84) (STATE FIRE)	670	INCENDIARY	8S,5E,SEC.35

HISTORICAL FIRES ON THE BLACK HILLS

YEAR	NAME		ACREAGE	CAUSE	LOCATION
1985	MILLER	(3/25/85)	33 (PVT)	DEBRIS BURN	4S,3E,SEC.16
1985	RAVE (STATE FIRE)	(4/15/85)	17 (PVT)	EQUIP.USE	2N,6E,SEC.18
1985	SCHMITZ RANCH (STATE FIRE)	(5/5/85)	40-FS 135-ST	DEBRIS BURN	2N,6E,SEC.24
1985	BEAR DEN	(6/20/85)	140	LIGHTNING	52N,63W,SEC.30
1985	COOL	(6/24/85)	40	LIGHTNING	42N,60W,SEC.16
1985	WHALEY (STATE FIRE)	(7/8/85)	225 (PVT)	MAN-CAUSED	8S,5E,SEC.9,10, 15,16
1985	WHOOPUP (WYO.)	(7/11/85)	839 (367 BLM,472 PVT)	LIGHTNING	43N,60W,SEC.18
1985	7-SISTERS (STATE FIRE)	(7/12/85)	9,714 (1670-FS,8044 PVT)	LIGHTNING	8S,5E,SEC. 2
1985	FLINT HILLS (STATE FIRE)	(7/12/85)	22,662 (9455-FS,13,207-PVT)	LIGHTNING	8S,4E,SEC.30
1985	BOUNDARY #2	(7/27/85)	1,141	LIGHTNING	6N,1E,SEC.19
1985	REUTER	(7/27/85)	82	LIGHTNING	51N,63W,SEC. 9
1985	INYAN KARA	(8/5/85)	60	LIGHTNING	49N,63W,SEC.25
1985	HARDING	(8/7/85)	30	LIGHTNING	55N,63W,SEC. 4
1985	LANTZ	(8/21/85)	6,880	CHAIN SAW	50N,62W,SEC. 1
1985	SEVEN	(8/30/85)	57	LIGHTNING	2N,2E,SEC.18

1986 - NONE